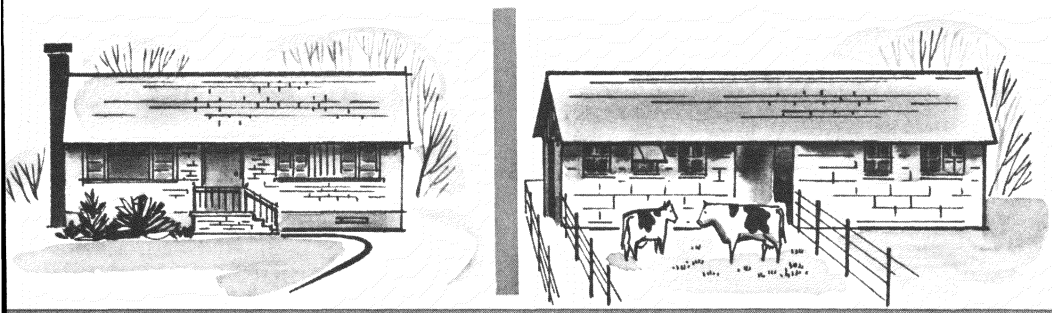
FIRE RESISTANT CONSTRUCTION

OF THE HOME . . . OF FARM BUILDINGS



FARMERS' BULLETIN NO. 2227 • U.S. DEPARTMENT OF AGRICULTURE

Other USDA publications on fire prevention and related subjects are:

FB 1889, "Fireplaces and Chimneys"
FB 2136, "Lightning Protection for the Farm"
FB 2150, "Safeguard Your Farm Against Fire"
FB 2170, "Roofing Farm Buildings"

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This publication supersedes Farmers' Bulletin 2070, "Fire-Resistant Construction on the Farm".

Washington, D.C. Issued September 1967

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 15 cents

FIRE RESISTANT CONSTRUCTION

• Of The Home

• Of Farm Buildings

By Merrill S. Timmins, Jr.,[1] *Architect, Agricultural Engineering Research Division, Agricultural Research Service*

Every year several thousand people lose their lives in house and farm-building fires. The loss in livestock, crops, machinery, buildings, and other property amounts to millions of dollars. Much of this tragedy and material loss could be prevented if more thought were given to the proper location and details of construction of farm buildings.

Fire-resistant construction of farm buildings reduces the chances of fires starting and slows the spread of fires that do get started. Proper spacing of buildings retards the spread of fire from one to another.

Location of Buildings

It is not practical to separate all farm buildings by distances that would completely insure against the spread of fire from one building to another. Such an arrangement could cause loss of valuable work time. It is possible, however, to select a site for a new building or to lay out a new farmstead so that labor can be used efficiently and there will be reasonable protection against the spread of fire.

A space of at least 100 feet between major buildings is needed to give adequate security from ignition by radiation. Heat radiated by a large fire, such as a burning barn filled with hay, would almost certainly ignite a frame building within 50 feet and might ignite one within 100 feet. Poultry brooder houses, heated hog houses, farm shops where welding is done, and buildings used for heated-air drying of grain or hay should be 100 to 150 feet from the house and barn if possible.

If buildings are spaced at these distances and grouped around a hard-surface court, the danger of fire spreading between buildings is greatly reduced. At the same time it is easy to reach all the buildings with trucks, tractors, and other equipment. Also, it will be relatively easy for firefighting equipment to reach all the buildings.

Figure 1 shows a good farmstead arrangement. The buildings are spaced far enough apart so the danger of fire spreading from one to another is minimized.

[1] The author gratefully acknowledges the suggestions given by the Rural Fire Protection and Prevention Committee of the National Fire Protection Association (60 Batterymarch St., Boston, Mass. 02110).

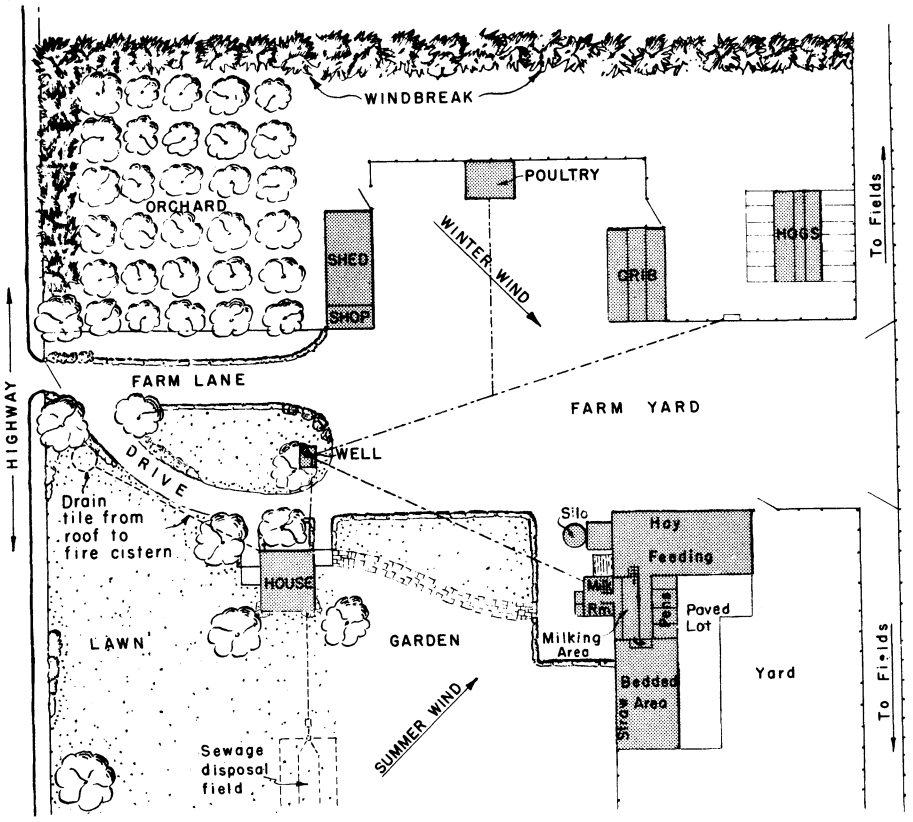

Figure 1.—The buildings in this farmstead are far enough apart for good protection against the spread of fire, yet are reasonably convenient. Note that the prevailing winds blow away from the house in the summer.

In some parts of the country it has been the custom to connect the house and barns with other buildings directly or by covered wooden passages as protection from the weather. This arrangement adds the fire hazards of each to the others and increases the risk of total loss of the major buildings in case of a fire. If connecting passages are necessary, they should be provided with a fire barrier at the center. The barrier should be a masonry partition, with a tight, heavy, self-closing door, preferably of noncombustible construction. If the roof is of frame construction, the barrier partition should extend through, and at least 18 inches above, the roof.

The direction of prevailing winds should be considered in arranging buildings for fire protection. If prevailing winds blow in the same direction as an imaginary line connecting the main buildings, the danger of fires spreading is considerably increased. In many areas the second most common wind direction is directly opposite that of the prevailing wind direction. As far as possible, main buildings should be laid out in a line at right angles to the line of the most common wind directions.

Windbreaks should be located where they will not be in danger of catching fire from a blaze in an adjacent woodlot or growth of brush. There should be enough distance between windbreaks and buildings so that if a windbreak ignites, the fire will not spread to a building.

House Construction

Farmhouses should be well protected against fire. Construction features for the special purpose of fire protection can be included when a house is built or can be added to most old houses. These features can be provided in all parts of the house, from the basement to the roof.

Basements

The basement ceiling should be high enough to permit the safe installation of heating equipment. In basements with low ceilings sufficient headroom for the heater may be provided by placing the heater in a well-drained, shallow pit. Where there is considerable ground water, the pit must be waterproofed or provided with an automatic sump pump or other arrangement for removing water. A noncombustible ceiling, such as wire lath and plaster, asbestos-cement board, or ½-inch gypsum board and plaster, should always be provided over the heating equipment and smoke pipe. Be sure, however, that there is adequate clearance.

The construction of the basement should be such that it will not contribute to spread of fire. Masonry walls and partitions, masonry piers, and reinforced concrete girders are fire resistant. Steel columns and girders are structurally strong, but they should be protected with a concrete or plaster covering as insulation. Unprotected steel columns and girders may buckle in a hot fire and open up floors and partitions, thus permitting rapid spread of fire.

If timber is used for posts or columns, it should be solid and at least 6 inches thick in the least dimension. (Should heavy timbers become charred during a fire, they provide excellent resistance against failure or destruction.) Wood pillars should stand on concrete or masonry footings extending at least 4 inches above the floor. The footings give protection against ground moisture and insects.

While not essential, a fire-resistant ceiling over the entire basement helps prevent the spread of fire. Such a ceiling may be made of ½-inch gypsum board and plaster, or of metal lath and plaster finished tightly against outer walls, sills, and girders. The walls and ceilings of stairways should be finished with the same material.

If a fire-resistant ceiling is not installed, the flooring above the basement should be double, with asphalt or tar paper between the layers. This type of floor reduces the spread of fire because there are no drafts through it. It also prevents dust from passing from the basement to the room above and is a warmer, stronger floor than a single-layer floor. A reinforced concrete or tile floor above the basement provides even better protection against the spread of fire and makes a ceiling in the basement unnecessary.

Masonry Walls

Masonry walls are often finished on the inside by placing finishing

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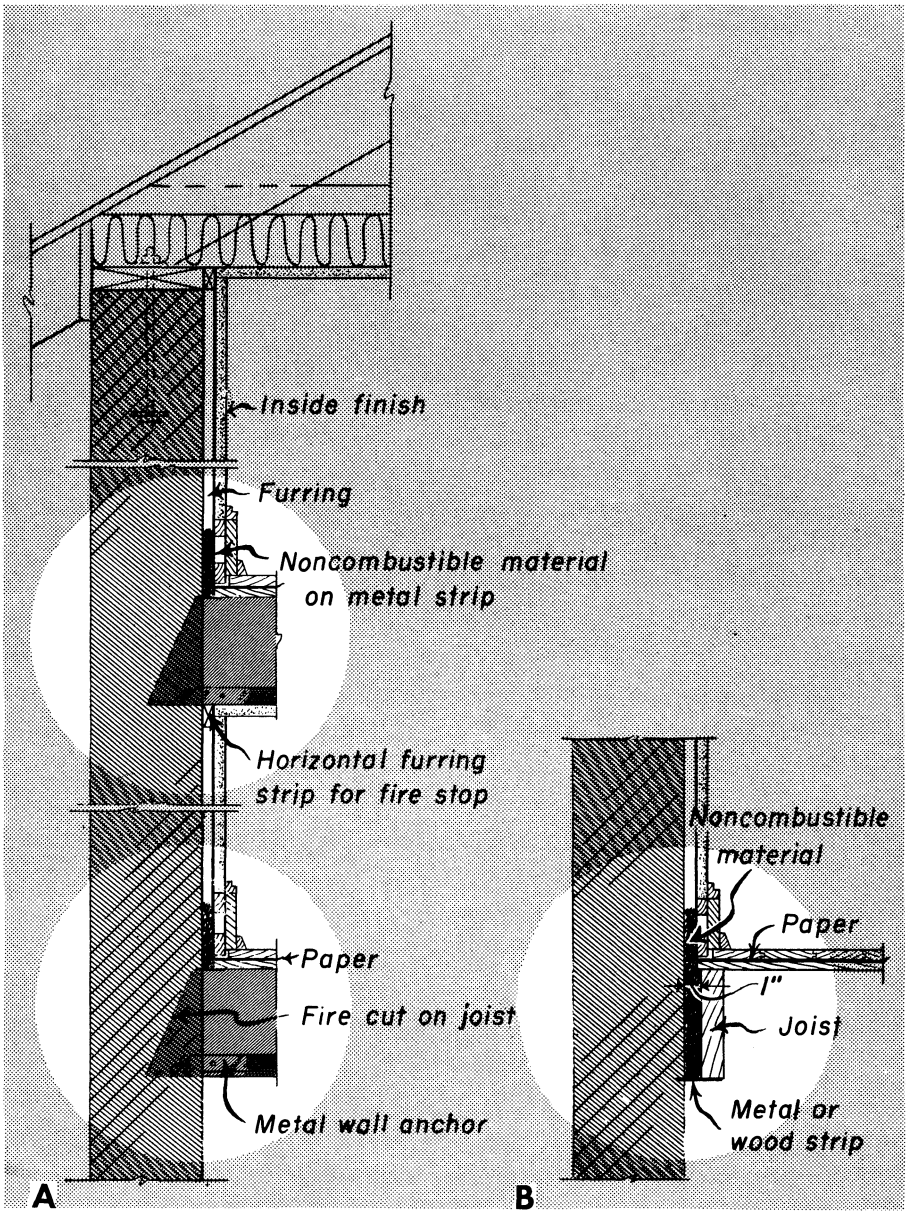

Figure 2.—If a building has masonry walls, the spread of fire in the flooring and wall finishing can be retarded: A, By providing firestopping between the masonry and the inside wall; or B, by setting the joists that run parallel to masonry walls 1 inch from the wall and packing the space between with noncombustible material.

material over furring strips. Firestopping (blocking material) is needed between the masonry and the finish if the spaces between the furring strips connect with the spaces between the joists in floors or ceilings (fig. 2, *A*).

Floor joists that extend into masonry walls should be cut diagonally at the ends, as shown in figure 2, *A*. If the joists burn enough to collapse, the diagonally cut ends are less likely to pull the walls down. Joists cut square on the ends would act as levers to pull down the walls.

Stairways

There may be loss of life if people are trapped on an upper floor and the only stairway is impassable because of fire or smoke. At least two means of escape should be provided.

An extra stairway may be well worth the cost because of the added safety and convenience it provides. It should be located so that both stairways are not likely to become impassable at the same time.

A window or door opening from an upper-floor room onto a porch or

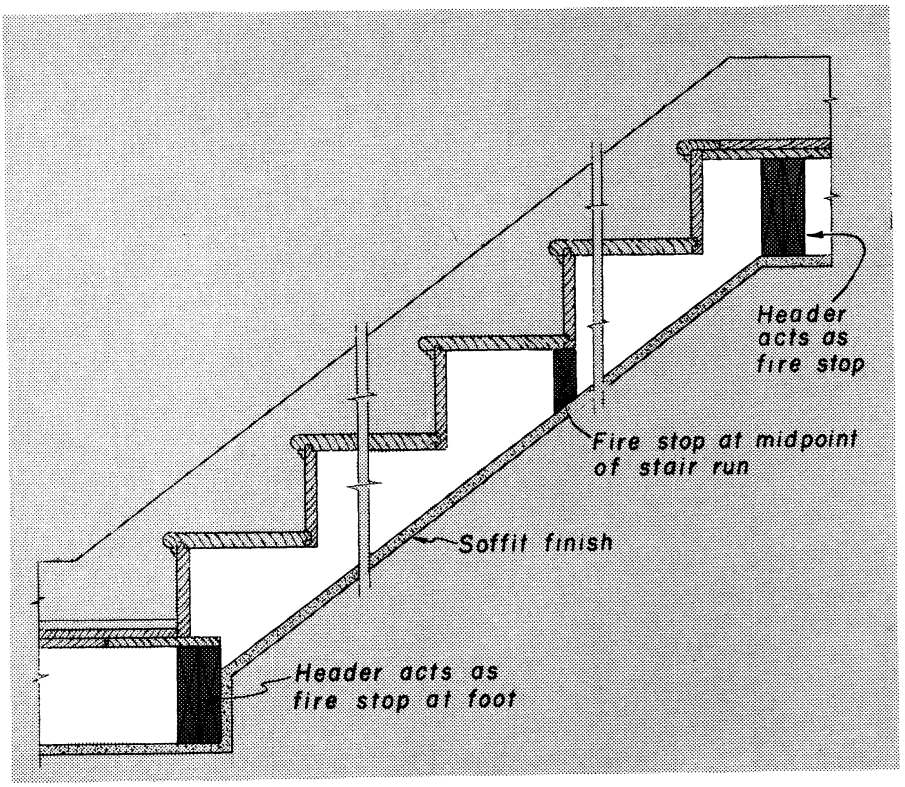

Figure 3.—Firestopping at the top and bottom will prevent a stairway from acting as a flue to spread fire. A long stairway should also have a firestop midway in the stair run.

porch roof is a good construction feature that has saved many lives in house fires. Windows to be used as fire escapes should not have storm windows that are not readily removed, permanently fastened wire screens, or metal frames too small for easy escape. Windows too high above the floor are of little use as fire escapes.

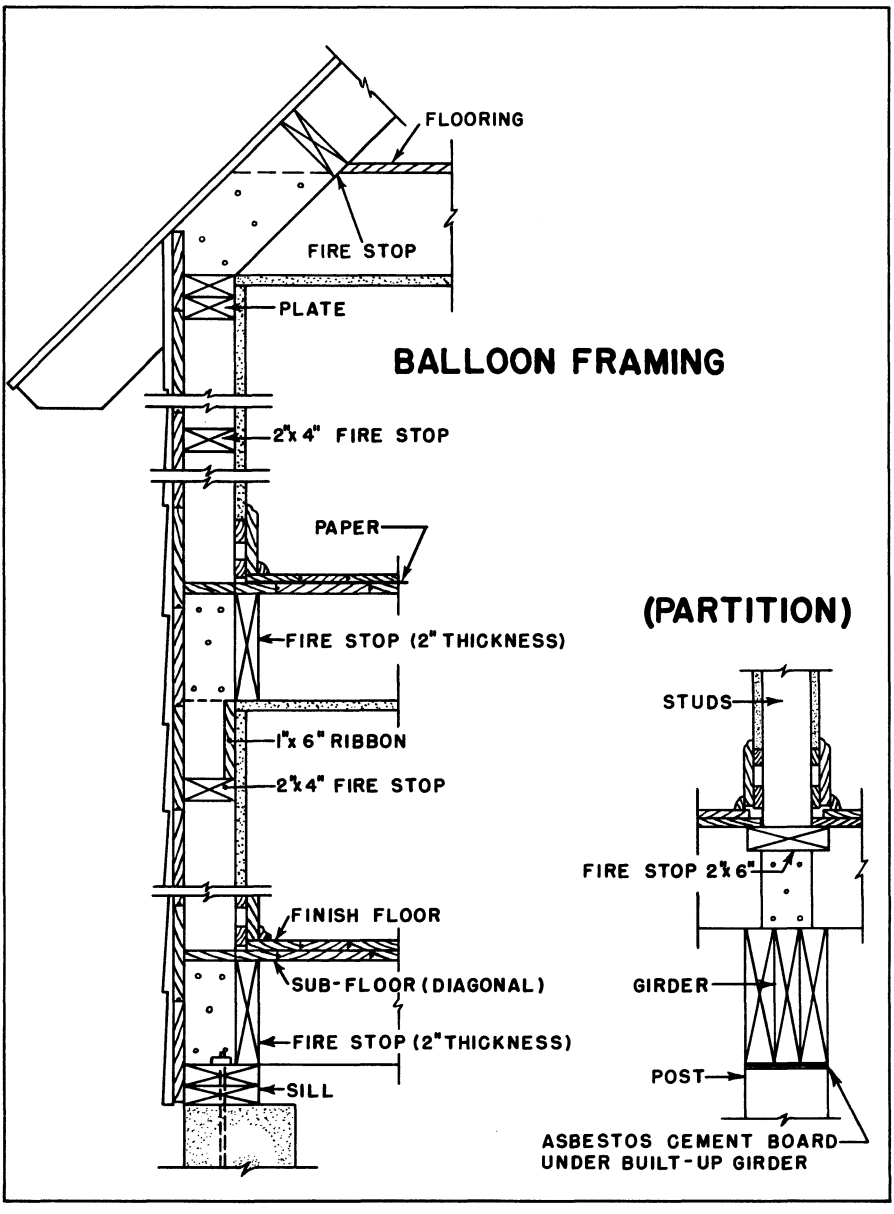

Figure 4.—Wooden blocks may be used to provide firestopping in houses with balloon framing.

The spaces under the treads between the carriages or stringers of stairways should be firestopped with plaster and heavy wooden blocking (fig. 3). If the stairway passes through a partition, firestopping should be placed at the partition to prevent the passage of fire from one room to another.

Open stairs permit rapid spread of heat, smoke, and fire because they act as chimneys for hot, gas-laden air to rush from the lower to the upper floors. They are especially dangerous in spreading fire if their base is in a hall or room having wide, doorless openings into other rooms. Open stairways and wide, doorless openings between the stair hall and other rooms are often desirable to make an attractive arrangement of rooms. For fire protection, however, it is desirable to have openings leading from the stair hall provided with doors. A closed hall may also help to conserve heat in winter.

Basement stairways should be closed at the top with a tight, heavy door.

Firestopping in Frame Buildings

In farmhouses with "balloon" framing (fig. 4), the hollow spaces between the studs in walls and partitions may be continuous from the basement to the attic and may also connect with the hollow spaces between joists. These spaces provide draft and act as chimneys that allow hot gases, smoke, and flames to spread rapidly. The structures are likely to be quickly destroyed in a fire.

The spread of gases, smoke, and flames in balloon framing can be prevented with firestopping. Figure 4 illustrates the use of wooden blocks for firestopping. A noncombustible material supported on metal strips can also be used. The cost of firestopping in new buildings is moderate; in old buildings, it may be costly and impractical to provide complete firestopping. However, even in old buildings, blocking can be readily installed at the walls between the first-floor joists.

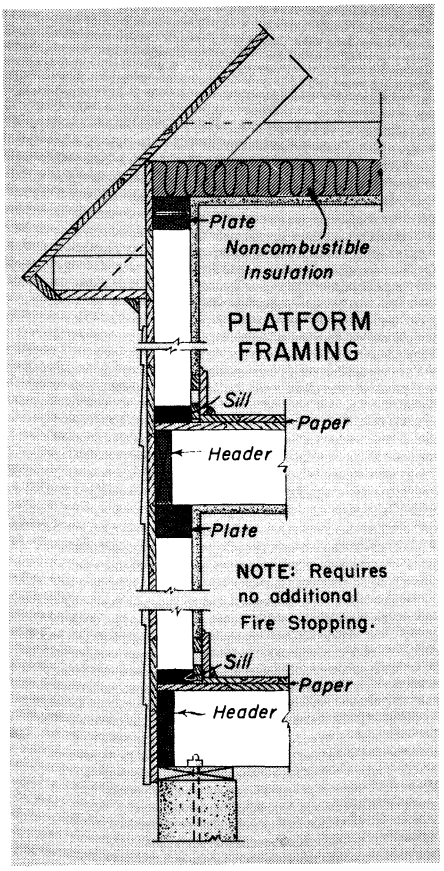

Figure 5.—In a house with platform framing, the sills and plates close the spaces between studs and act as firestopping.

Noncombustible insulation material is an effective firestop if it completely fills the spaces between studs.

Figure 5 illustrates firestopping in a frame building with "platform" framing.

Wooden firestops should be cut from lumber of correct size, commonly 2 inch, and must fit openings tightly to prevent the passage of air or hot gases. Cracks around stopping may be calked with plaster. The stopping in vertical air spaces may be sealed by covering the top with a 3- or 4-inch layer of a noncombustible material such as mineral wool, broken-up mortar, plaster, concrete, brick, cinders, or a mixture of sand and gravel.

Chimney Construction

Defects in chimneys, smoke pipes, and chimney connections are frequent causes of fires in houses. Care in setting smoke pipes and making proper connections between smoke pipes and chimneys can greatly reduce the danger of fires due to defective construction. Do not attach antennas to chimneys. Wind causes them to vibrate. The vibrations will in time weaken mortar joints and cause cracks and leaks. Cracks and

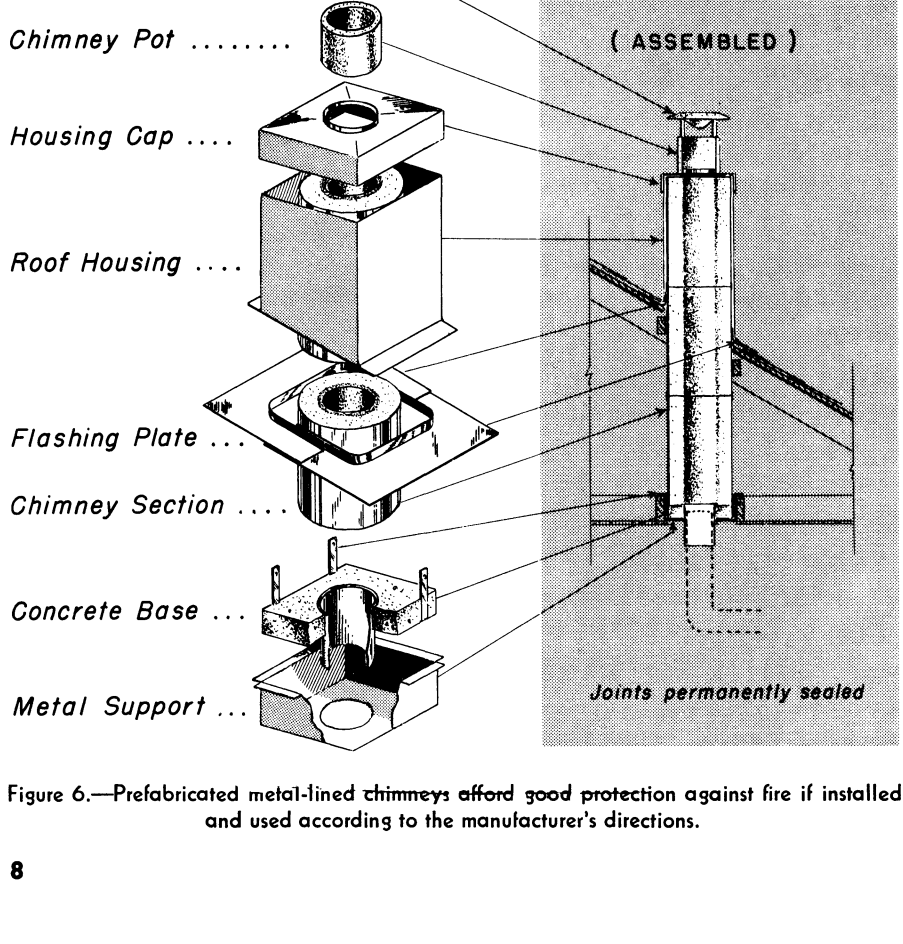

Figure 6.—Prefabricated metal-lined chimneys afford good protection against fire if installed and used according to the manufacturer's directions.

leaks not only reduce the effectiveness of the chimney, but also may permit sparks or hot gases to escape and become a fire hazard.

Masonry chimneys should rest firmly on an adequate foundation below frost level and not on wall brackets. They should have fire-resistant flue linings for efficient operation and fire safety.

No wood framing, furring, lathing, or other burnable material should be built into or be in direct contact with the masonry of a chimney. There should be a clearance of at least 2 inches between the chimney and any combustible material. The space should be filled with loose, noncombustible material held by strips of metal lath or wire fabric.

Patented, metal-lined flues (fig. 6) can be purchased and substituted for masonry chimneys. They should be approved by Underwriters' Laboratories for the type of fuel to be used. Some metal-lined chimneys may be used only in one-story houses.

Every flue should be subjected to a smoke test before the heater is connected. Build a paper, wood, or tar paper fire at the base of the flue. Tightly block the outlet at the top with a board or a wet sack. If there is a leak along the length of the flue, smoke will appear at the opening. Remedy the defect before the flue is used.

For additional information on fireplaces and chimneys, see list of publications, page ii.

Radio and Television Antennas

Radio and television antennas should be substantial enough to withstand any wind, snow, or ice load that might cause them to fall over power wires. If possible, install antennas where they could not fall on power lines if they should topple over. The lead-in conductors should be placed at least 6 feet away from any part of a lightning-rod system.

Antennas should be equipped with lightning arresters approved by Underwriters' Laboratories and should be effectively grounded. Installation should be in accordance with the requirements of the National Electrical Code.

Roofing

The roof covering is one of the points most vulnerable to fire. The fire and wind resistance of a roof covering is determined by the kind of material of which it is made and the manner in which it is applied and maintained. There are a number of roofing materials available which afford satisfactory protection and service if applied and maintained in accordance with the manufacturers' directions. Tile, slate, asbestos-cement shingles, and metal are the most fire-resistant roof coverings.

Asbestos-cement, asphalt, and composition roofing materials are given fire-resistance ratings of various classes by the Underwriters' Laboratories. Roof coverings with a Class A rating are effective against severe exposure, those with a Class B rating are effective against moderate fire exposure, and coverings

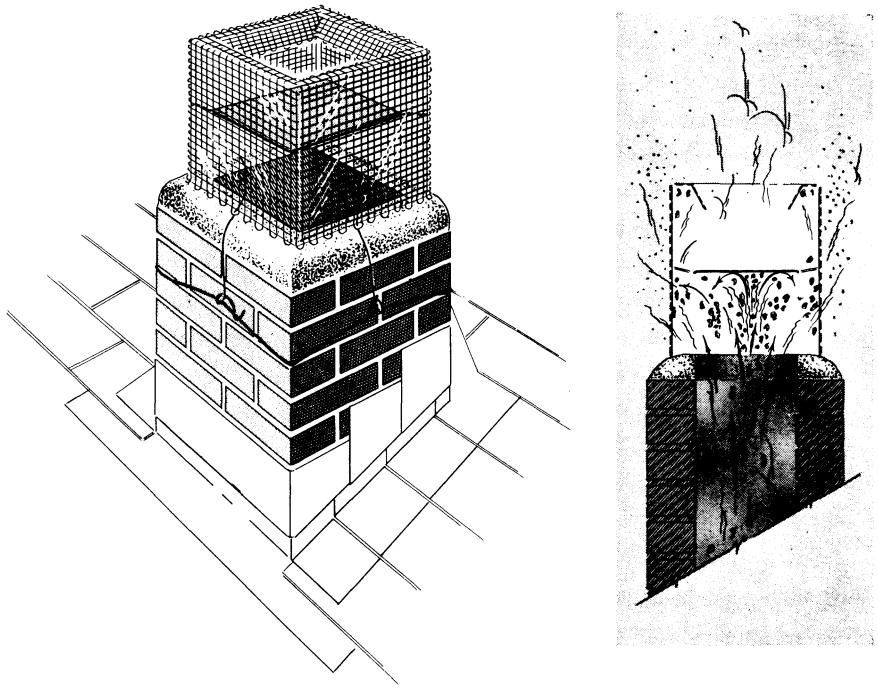

Figure 7.—Install spark arresters on chimneys to prevent sparks from flying out and falling on the roof.

with a Class C rating are effective against light fire exposure. Do not buy bundles or packages of roofing material unless they are labeled as to class.

The roofs on farm buildings 100 feet or more apart may be considered as being subject to only light fire exposure and a Class C roofing will be satisfactory. However, a better grade of roofing will give longer and better service, as well as increased fire protection.

A good roofing material for the farmhouse is especially important because the heating equipment in the house is frequently the cause of roof fires.

Provide a spark arrester (fig. 7) on the chimney of a house with a wood-shingle roof.

For additional information on roofing for farm buildings, see list of publications, page ii.

Electrical Equipment for Houses

Electric wiring must be planned on the basis of the expected electrical load. First, list all of the equipment that will be used. Then have an experienced electrician or electrical engineer determine the sizes of wires, the number and location of outlets, and the number and fusing of circuits required. Heavy or fixed appliances, such as the range, water heater, refrigerator, air-conditioner, water-supply pump, and oil burner, should each have its own circuit.

Wiring should be done by an experienced electrician in accordance with the National Electrical Code and State and local regulations. After wiring has been installed, it should be inspected by an authorized inspector. If the wiring gets damaged in any way, it should be repaired promptly and properly.

Fuses or circuit breakers should be used on branch circuits to limit the amount of current flowing through the circuits to the amount for which the circuit was designed. Fuses that allow the maximum safe current for the respective wire sizes are as follows:

Gage of wire *Number*	Capacity of fuse or circuit breaker *Amperes*
14	15
12	20
10	30
6	50

Number 14 wire is sometimes permitted but it is usually too small for farm use even in dwellings, and is wasteful of electric power.

Branch circuits on which motors are operated should be equipped with "time lag" fuses or circuit breakers. These are designed to handle the heavier starting load of motors and still give protection against overheating of wires.

Electric heaters and infrared lamps must have proper guards and must be located far enough away from combustible material, such as wood or straw, to avoid ignition of the material. A unit should be suspended securely by chain or bracket.

Additional information and guidance on the safe installation and use of electricity can be obtained from electric-power companies.

Fuel-Burning Equipment

Most cities, towns, and counties have regulations and/or codes governing the installation of fuel-burning equipment used for heating and cooking, but some rural areas may not. These four points should be kept in mind when installations are made in areas where there are no regulations: (1) Insulation and metal sheets placed against wood surfaces do not make them fireproof; (2) insulation slows down the movement of heat but does not stop it; (3) repeated heating and cooling of wood makes it drier and easier to ignite; and (4) for practical purposes wood or other combustible material may be considered unsafe if it is so hot the bare hand cannot be held comfortably against it.

Most furnaces, boilers, and other heating equipment and fuel tanks should be set on concrete or masonry foundations. Each type of equipment has special requirements for space, mounting, and venting.

Warm-air ducts should be so arranged that the heated air must travel at least 6 feet from the furnace and make a sharp bend before entering floors or walls. The ducts may be single-wall ducts covered with asbestos paper at the rate of 12 pounds per 100 square feet if an air space of at least five-sixteenths inch is maintained between the duct and any wood surface such as studs or wood lath. Install ducts in accordance with the manufacturer's directions and local code requirements.

All flame-producing, fuel-burning devices must have an adequate air supply for safe operation. Heating plants that are starved for air are likely to give off carbon monoxide, and an explosion of unburned

gases may occur. If the basement or boiler room is very tight, leave a window open or provide louvers in the door to admit oxygen that will insure complete combustion.

Wood- and Coal-Burning Systems

The clearances required between wood- and coal-burning systems and ceilings and walls varies with the different types of systems. However, a clearance of 48 inches between the front of the unit and the wall is safe for all systems.

Some systems have openings for smoke pipes in the top of the unit. These units must be installed so that the pipe makes a 90° bend and the section of pipe that enters the wall is horizontal. The horizontal section of pipe must be at least 18 inches from the ceiling, and the vertical section that rises from the unit at least 18 inches from the walls. Other clearances for units with a smokepipe opening in the top are as follows:

- Conventional warm-air furnaces—18 inches clearance at the top, back, and sides.
- Domestic ranges without firepot lining—36 inches clearance at the top, back, and sides.
- Domestic ranges with firepot lining—36 inches clearance at the top, 12 inches at the back, and 24 inches at the sides.
- Circulating-type space heaters—36 inches clearance at the top and 12 inches clearance at the back and sides.
- Radiating-type heating stoves—36 inches clearance at the top, back, and sides.
- Stove-type incinerators—36 inches clearance at the top, back, and sides.

Some wood- and coal-burning systems have the smoke-pipe opening in the back. A vertical section of pipe must be between the unit and the horizontal section of pipe that fits into the chimney opening. At least 18 inches clearance must be between the vertical section of pipe and the wall, and 18 inches clearance between the horizontal section of pipe and the ceiling. Other clearances for units of this type are as follows:

- Mechanical warm-air furnaces with temperature-limit control—6 inches clearance at the top, back, and sides.
- Domestic-type hot-water and steam boilers—6 inches clearance at the top, back, and sides.
- Water heaters—12 inches clearance at the top, back, and sides.

Hand-fired, forced-air furnaces that burn wood or coal may overheat because of insufficient cold-air return when the fan is stopped by fan-belt breakage, motor failure, or power failure. With no air to carry away the heat, temperatures get dangerously high. Overheating can be controlled with protective devices that provide thermostatic control for opening and closing the ashpit damper. Excessive temperatures cause the devices to close the damper, thus checking combustion. Coal stokers are also equipped with automatic controls.

Oil- and Gas-Burning Systems

Oil- and gas-fired heating plants are often less of a fire hazard than plants using coal or wood because they are usually equipped with automatic temperature-limit controls. Units that carry the label of Underwriters' Laboratories, Oil Burner Institute, or the American Gas Association assure compliance with minimum safe standards.

Any leak in a system using flammable liquids or gas fuels (including LP gas or natural gas) may present a serious fire hazard. The vapors from LP gas are heavier than air and tend to settle to the floor or other low areas. They are highly flammable and burn with explosive rapidity. If these fuels will be used, provision should be made for possible leakage vapors to flow away. This may be difficult in basements wholly underground. Liquefied petroleum gas containers should be outdoors and at least 3 feet away from basement wall openings.

Drainage for LP gas vapors may be provided by leaving a 2- or 3-inch opening across the top and bottom of the doors to the outside. The floor of the furnace or boiler room must be higher than the surrounding grade, otherwise vapors will remain in the furnace room or basement like water behind a dam. A more positive way to take care of such vapors is to use forced ventilation. The exhaust duct should take the air from a point within 2 inches of the lowest part of the floor. Electric exhaust fans should be installed in accordance with the National Electrical Code.

Floor and Pipeless Furnaces

Floor furnaces hang from the floor joists by flanges attached to the furnace shell. If it is necessary to remove a section of floor joist to hang a furnace, substantial headers must be placed across the end of the sawed-off joist, and joists that carry the headers should be reinforced by using doubled joist to carry the additional weight.

Pipeless furnaces are supported in the same manner as piped furnaces. The shells form the cool-air return of pipeless and floor furnaces.

Lightning Protection

Lightning is a major cause of farm fires. A correctly installed and maintained lightning-protection system provides almost complete protection to buildings. However, such systems may not protect electrical services from lightning-induced surges unless these services are provided with properly installed lightning-surge arrestors.

The type of equipment used in a lightning-protection system and the method of installation are most important. All installations should be made by experienced persons in accordance with the manufacturers' instructions. Every lightning-protection system should have an Underwriters' Laboratories "Master Label" indicating that it has been properly installed and grounded.

For additional information on lightning protection for the farm, see list of publications, page ii.

Service Building Construction

Service buildings should be arranged and located so that they are readily accessible not only to service trucks but also to fire department equipment. This accessibility should be effective throughout the year.

Farmers who plan to construct new buildings may reduce fire risk by using fire-resistant materials.

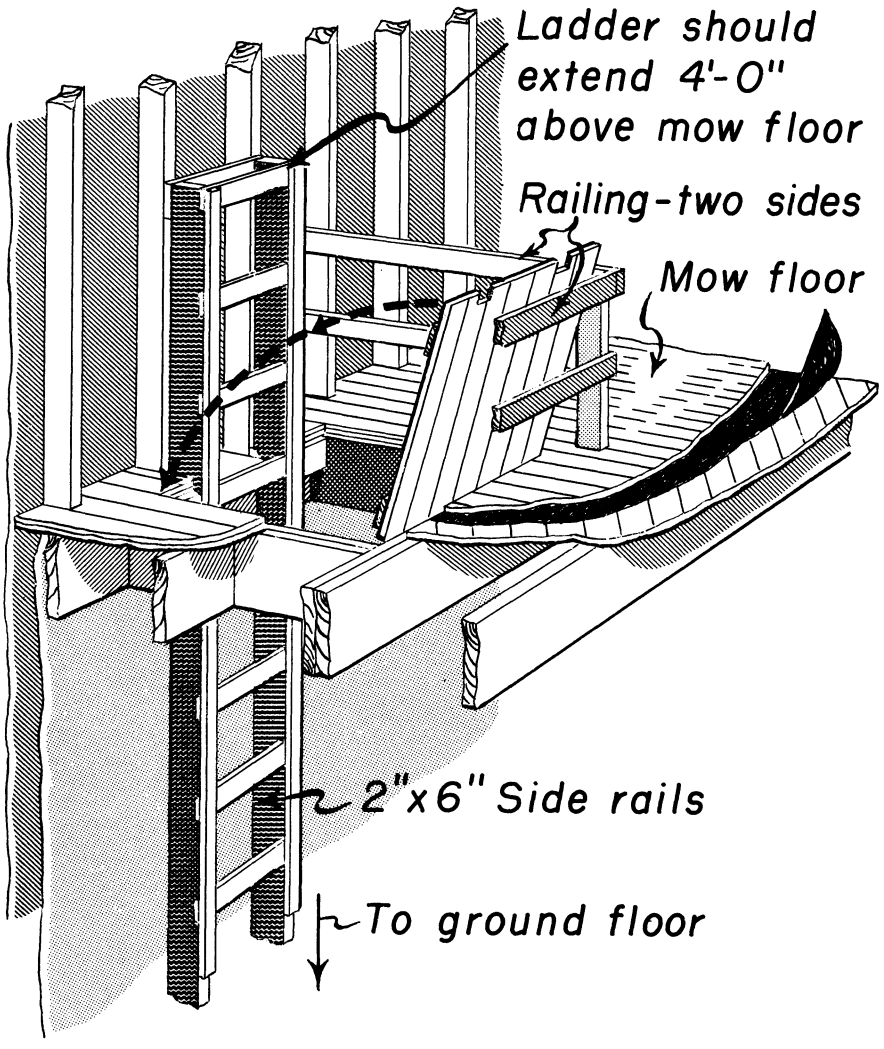

Figure 8.—A tight door between the lower floor and the mow provides fire protection by preventing drafts.

In remodeling or making major repairs, install fire walls and fire doors, provide better protection of electrical circuits, and use fire-resistant materials.

Additional protection against fire can be provided by protecting and subdividing wood or metal framing to retard the spread of fire.

Livestock Barns

It is usually impossible to build the walls and roofs of mows with materials that would completely withstand the heat of a mow fire. However, masonry walls and roofs of fire-resistant materials may suppress the spread of fire to other buildings. The roof covering should

be of the type that gives protection against flying brands from another fire. Roofs and walls should be weathertight because even cured hay may ignite spontaneously if wet by rain or snow.

The construction of frame and masonry barns should provide all possible barriers to the spread of fire. If the mow floor is of 1-inch flooring, it should consist of at least two layers. A mow fire would have to burn for a considerable time before a two-layer floor would be damaged enough to let burning hay drop into the area below. The boards of the top layer should cover the joints of the bottom layer and should be of matched lumber. Additional protection is afforded if asbestos paper or sheets are laid between the layers of flooring.

A reinforced-concrete floor is a more effective fire barrier than a

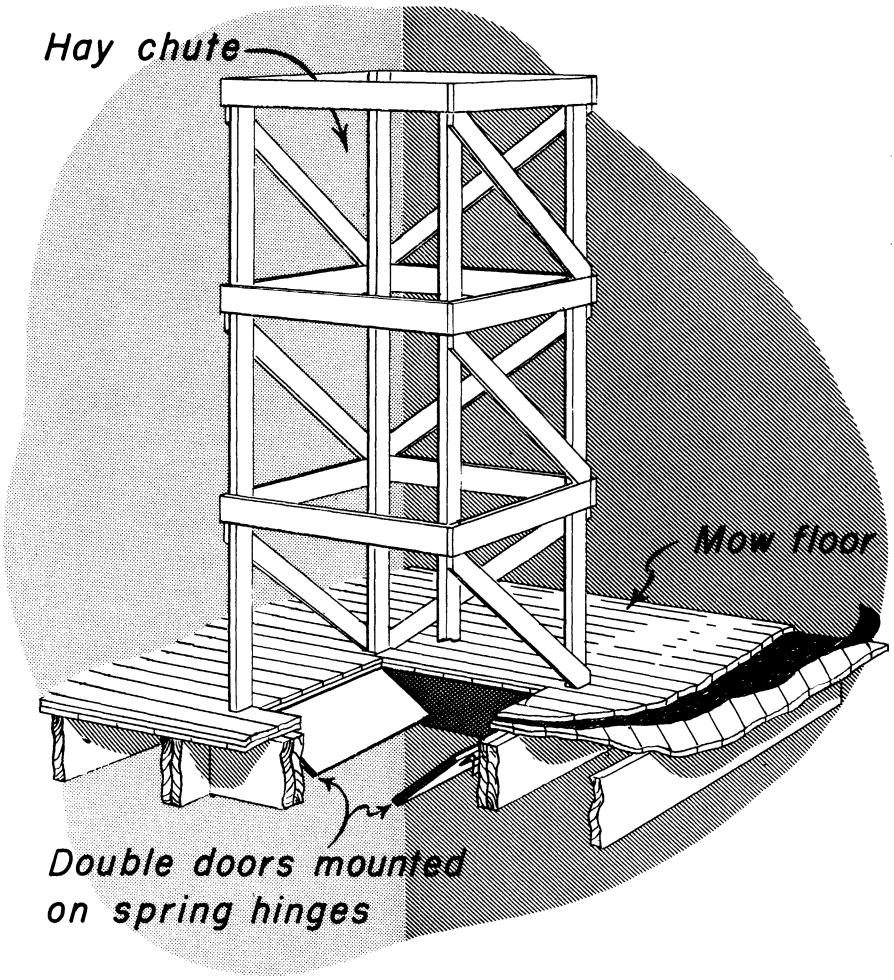

Figure 9.—Circulation of air through hay chutes may be prevented by installing a trapdoor at the mow floor.

wood floor and in some localities may not cost much more than a well-laid wood floor. A mow floor of concrete should be used only if the supporting sidewalls are of masonry or concrete construction.

It is desirable to line the ceiling of the dairy stable. A lined ceiling is an aid in keeping the barn clean and also gives the livestock added protection from a mow fire. Asbestos-cement board ¼ inch thick, or ½-inch gypsum board and plaster, are good materials for this purpose. Cold drafts over the ceiling can be prevented by tightly stopping the joist spaces at the outside walls. If the joist spaces are not stopped, the ceiling should be insulated. If the walls of the stable are lined, firestopping should be installed in the stud spaces to prevent the spread of fire through the wall frames. The installation of firestopping is discussed in the section, "Firestopping in Frame Buildings" (page 7).

Stairways or ladder hatchways from the lower floor to the mow should be provided with tight, heavy doors (fig. 8) that will stay closed by their own weight, or they should be held closed by a wire rope and weight.

Hay chutes should be constructed so as to prevent the passage of air between the stable and the mow. This can be done by closing the chute opening in the mow floor with a counterbalanced door (fig. 9). If a door is not installed in the floor opening, a closed chute should extend down to the stable floor and have a tight-fitting door at the bottom. Never use hay chutes as ventilating flues for the stable.

In one-story barns, a wall of noncombustible or fire-resistant material, preferably masonry, should separate the stable area from the hay or feed storage area. Extend the wall above the roof. Any doors in the wall should be a fire-resistant, self-closing type.

Tobacco Barns

Flues in tobacco barns should be 12 inches or more from combustible sills or walls. Heating units should be at least 28 inches from combustible material and must not be operated at temperatures above those for which the equipment was designed. Fifteen inches or more of masonry must be provided between the furnace and any combustible part of the frame structure.

Locate the bottom tier poles high enough so that the tobacco will hang not closer than 3 feet above the flues or other heating equipment. Suspend poultry netting over the furnaces and flues to catch falling sticks and leaves. Each section of smoke pipe should be securely wired to adjoining sections, or sections may be connected with sheet-metal screws on opposite sides of the pipe.

The stack elbow coming from the barn should be supported on a masonry footing. If a metal stack is used, it should be at least its own diameter from the barn and anchored in four directions with wire or metal bands. A clearance of 12 inches between the stack and flammable material should be allowed if the stack passes through a roof or wall. Better draft and less fire hazard may be expected if the stack extends about 2 feet above the ridge of the barn roof.

Where oil- or gas-fired burners are used, they should be under thermostatic control. If several burners are located on the floor of the barn, the top of the burner should have a slope great enough to prevent ac-

cumulation of dropped leaf particles.

Poultry Houses

Multistory poultry houses should be provided with tight-fitting doors at stairways to slow down the spread of flames and asphyxiating smoke in case of fire.

Gas heaters and brooders may be fire hazards if they are not carefully installed and supervised. Gas heaters should be equipped with a 100-percent-automatic shutoff to stop flow of gas in case of flame or pilot failure. LP gas tanks should be located outside the building away from openings. Carefully supported and protected copper tubing should be used for fuel lines except where a short, flexible connection is needed. For example, a short, flexible connection at the hover is needed so that the hover can be raised and lowered. Oil brooders also must be carefully installed to avoid oil leakage or flooding. All types of heating devices should be kept clean and in good operating condition to avoid fire hazards.

Infrared lamps and other high-temperature equipment used in brooder houses, farrowing houses, or lambing pens should be protected with metal guards that will prevent the heating units from touching the litter if they break or fall. This type of equipment should be mounted out of reach of animals and so placed that heat from the unit cannot ignite any combustible materials. It should be suspended securely by chain or bracket. The cord leading to the receptacle should not be used to provide support for the unit.

The Farm Shop

The farm shop is usually a part of the machinery storage building. It should not be located in or close to a building where hay, straw, oil, or other combustible material is stored. The shop should have a concrete floor and should be well ventilated to protect against the fire hazard caused by the use of flammable liquids and oily rags. Proper mechanical ventilation is particularly needed if spray painting is done in the shop and should be installed in accordance with recommendations of NFPA (National Fire Protection Association) Standard No. 33. Benches for welding must not be of wood or other combustible material.

Electrical and Heating Equipment for Service Buildings

Installation of electrical wiring should conform to the National Electrical Code. The wiring should be planned by a competent electrician or engineer and should be large enough to carry the expected load for all the equipment to be operated. All circuits must be protected by fuses or circuit breakers of the proper size.

Separate circuits must be installed in buildings where large electric motors will be used. All motors one-half horsepower or larger must be on a separate circuit.

Wiring in barns and other service buildings must be installed in such a way that it cannot be damaged by livestock, equipment, or other means.

Wiring systems should be electrically grounded. It is also important to have metal stanchions and drinking cups electrically grounded at both ends of the line of stanchions. All metal work 6 feet or longer

should be grounded by interconnection with other metal work or ground-wire connections.

Electric lights in hay mows or other dusty places should be equipped with dusttight fixtures or placed inside glass jars. Bare lamps become hot enough to ignite dust or particles of hay which settle on them. Switches also should be dustproof. A lamp should never be suspended by the electrical cord or wires.

Electric-, gas-, and oil-heating equipment should not be used unless it bears the label of Underwriters' Laboratories, the American Gas Association, the Oil Burner Institute, or the National Fire Protection Association LP Gas Code. Installation must be in accordance with the manufacturer's directions and the National Fire Protection Association's national fire codes.

Coal- or wood-burning stoves in brooder houses, farrowing houses, milkhouses, potato and sweetpotato storage, and other utility buildings should have chimneys which conform to the requirements for dwellings (see p. 8). Clearances between stoves and woodwork should be as indicated in the section, "Wood- and Coal-Burning Systems" (p. 12). Stoves in buildings with wood floors should be set on metal-covered shields or in shallow boxes of sand large enough to catch hot ashes or embers falling out of the stove door. The metal shields or the boxes of sand should extend at least 12 inches out on the sides and back and 18 inches out in front.

Crop Driers and Feed Mills

Crop driers are fire hazards if they are improperly installed or operated. They should be installed in accordance with NFPA Code on Crop Driers. When existing storage is used for drying crops, the drier should be connected to the crib or bin by a noncombustible duct at least 10 feet long. Permanent, fire-resistant, complete drying units should be located at the distance from other buildings that is specified by insurance companies involved.

Many farms are equipped with feed grinding and processing plants. These plants become very dusty, and are subject to the same hazards as grain elevators and feed mills. This hazardous dusty situation requires the installation of dusttight wiring and equipment and totally enclosed motors to prevent any spark from being exposed to fine dusty materials. Fine dust is a highly combustible material that will explode and burn with the same aspects as volatile fuels.

U.S. GOVERNMENT PRINTING OFFICE: 1967 O—260-708